3024-30175

Period 2 CS 5
ECC1
13 October 1998

There are 3 tracks from the primary vertex. Two are at large angles and hit the Rosie magnet, and track #2, the τ candidate, leaves the primary vertex at 30mr and shows a 93mr kink 4.5mm downstream, which in the base (acrylic plastic) of plate 9. An $e^{\pm}$ pair is measured in plate 2, 14mm from the primary, and is clearly associated with track #2. The daughter candidate track interacts and showers in ECC3. Further, this track was followed into ECC3 and another associated $e^{\pm}$ pair was found in the emulsion. It is almost certain that this track is identified as an electron (no sign determination possible).

Track #1 clearly scatters in both ECC3 and E/B4 and is consistent with a momentum of 0.6 GeV/c. It also scatters in the emulsion measurements consistent with $p < 1$ GeV/c.

There are some soft shower tracks visible in the VDC, but no discernible tracks in the DCs. The calorimeter shows 0.94 GeV in 4 hits (assumed γs) with one of the hits very near the projected position of track #2. There are no muon track candidates in the muon ID system.

The most important parameter of this event is the momentum of the daughter track #2. The initial energy of the electron can be estimated using the number of shower hits in the SFT system. This analysis is appropriate in this case, as the multiplicity of the event is low and the shower is well isolated from other tracks or interactions in the emulsions. Consult the reference [http://fn872.fnal.gov/an/an-016.pdf] about the analysis. From the u-view, the number of SFT hits in plane 23 (immediately downstream of Station 3) is found to be 13±2. For the v-view the results are also 13±2 hits giving a central value of 3.95 GeV. These results were obtained with SFT decoder 2 (pixel Æ fiber). The 63% confidence level ("1 s") has a range of 1.7 to 8.0 GeV and the 90% CL is 1.2 to 15 GeV and the 99% CL range is 0.9 to >30 GeV. The calorimeter energy has some information, but only constrains the energy weakly. For the measured value of 0.94 GeV, the 1σ predicted lower limit in energy is 5.5 GeV (in ECC1) and the most probable value is 8.1 GeV . A value of 4.0 GeV is taken as the most probable value of E_e . The p_T of the electron with this central value is 370 MeV/c with a 90% CL lower limit of 110 MeV.

Background Analysis

The event parameters 1 through 5 can be used to compare the probability of being from a ν_τ distribution or from a distribution from a background source. A simpler analysis can be used to compare the relative probability of the tau hypothesis with (a) e scattering where the electron originates in a charged-current interaction or (b) hadronic scattering.

Assuming the charm hypothesis (a), the charged lepton (muon) is not recognized as such. There are only two other tracks from the primary, both at large angles, so assume that the track with the smaller angle, 240mrad with respect to the beamline, is a muon which will be outside the acceptance of the muon ID system. This can be estimated by Monte Carlo, with the only uncertainty being the energy spectrum of the neutrino. Furthermore, the identity of the daughter is an electron, with high probability, so one can use the branching ratio for $D^{\pm} \to K \nu e$, which is 7%. The ratio of the products of the columns in Table 1 gives an estimate for the probability of this event being charm relative to being a ν_τ interaction. The ratio, 4×10^{-3}, shows that the charm hypothesis is strongly disfavored.

For (b), the identity of the daughter is ignored, and is assumed to be a hadron (π). From the

Monte Carlo, the probability of any scattering of at least 5 mrad in module E/B2 is known as function of depth (z). So the relative probability of scattering in plastic to steel can be extracted. This relative probability that a scatter occurs is calculated by GEANT to be 0.04 in 800 μm of plastic (E/B type sheet) implying that a scatter in 200 μm of plastic (appropriate for ECC1) has a relative probability of 0.01. The absolute probability of scattering in a single plate with $\Delta\theta$ greater than some value is known from a different study (for 5 or less steel plates). A hadronic interaction that gives $\Delta\theta > 95$ mrad is 0.1 for all momenta > 0.5 GeV/c. Assuming that the angular distribution of scattering in plastic is the same as iron, one gets the product 1×10^{-3} for scattering in a base sheet for ECC3. The ratio of the products from the columns in Table 2 give a relative probability of 6×10^{-5}. The hadronic interaction hypothesis is rejected.

Another possible background is from strange particle decay, of which chraged K decay is the most likely. The assumed process is a NC interaction produces two K mesons, a process that the Monte Carlo predicts happens for 30% of the NC events. It also predicts the momenta as 9.7 GeV/c which strongly limits the chance of decaying within 4.5mm. Also, the only significant braching fraction is $K \to \pi^0 e \nu$, with probability 4.8%. Since this is a 3-body decay, the amount of overlap between the K decay phase space and the τ phase-space is 10%. This process is a very small background in this event.

Plots and Tables

Hypothesis :	$\nu_\mu \to D^\pm \to e\ X$		$\nu_\tau \to \tau \to e\ X$
$P(\theta_\mu > 240\ \mathrm{mrad})$	0.02	$P(\theta_{any\ had} > 240\ \mathrm{mrad})$	1.00
$P(\nu \to charm)$	0.07	$P(\nu \to \tau)$	0.05
$P(charm \to D^\pm)$	0.40	$P(\tau \to X^\pm)$	1.00
$P(D^\pm \to e\ X)$	0.07	$P(\tau \to e\ X)$	0.18
$\Pi\ P_i$	3.9×10^{-5}		9.0×10^{-3}

Table 1. Charm background estimate.
The ratio of *charm* to tau hypotheses is 4.3×10^{-3} .

Hypothesis :	$\nu_\mu \to \theta_{had} \to \theta_{had}'$		$\nu_\tau \to \tau \to e\ X$
$P(\theta_{had} > 95\ \mathrm{mrad})_{\mathrm{plastic}}$	0.001	$P(\theta_d > 95\ \mathrm{mrad})$	0.20
$P(p_{had} > 3\ \mathrm{GeV/c})$	0.03	$P(p_d < 3\ \mathrm{GeV/c})$	0.50
$P(\theta_{had} < 30\ \mathrm{mrad})$	0.02	$P(\theta_{lep} < 30\ \mathrm{mrad})$	0.50
$P(L_{dec} > 4.5\ \mathrm{mm})$	1.00	$P(L_{dec} > 4.5\ \mathrm{mm})$	0.20
$\Pi\ P_i$	$6.\times10^{-7}$		1.0×10^{-2}

Table 2. Hadronic background estimate.
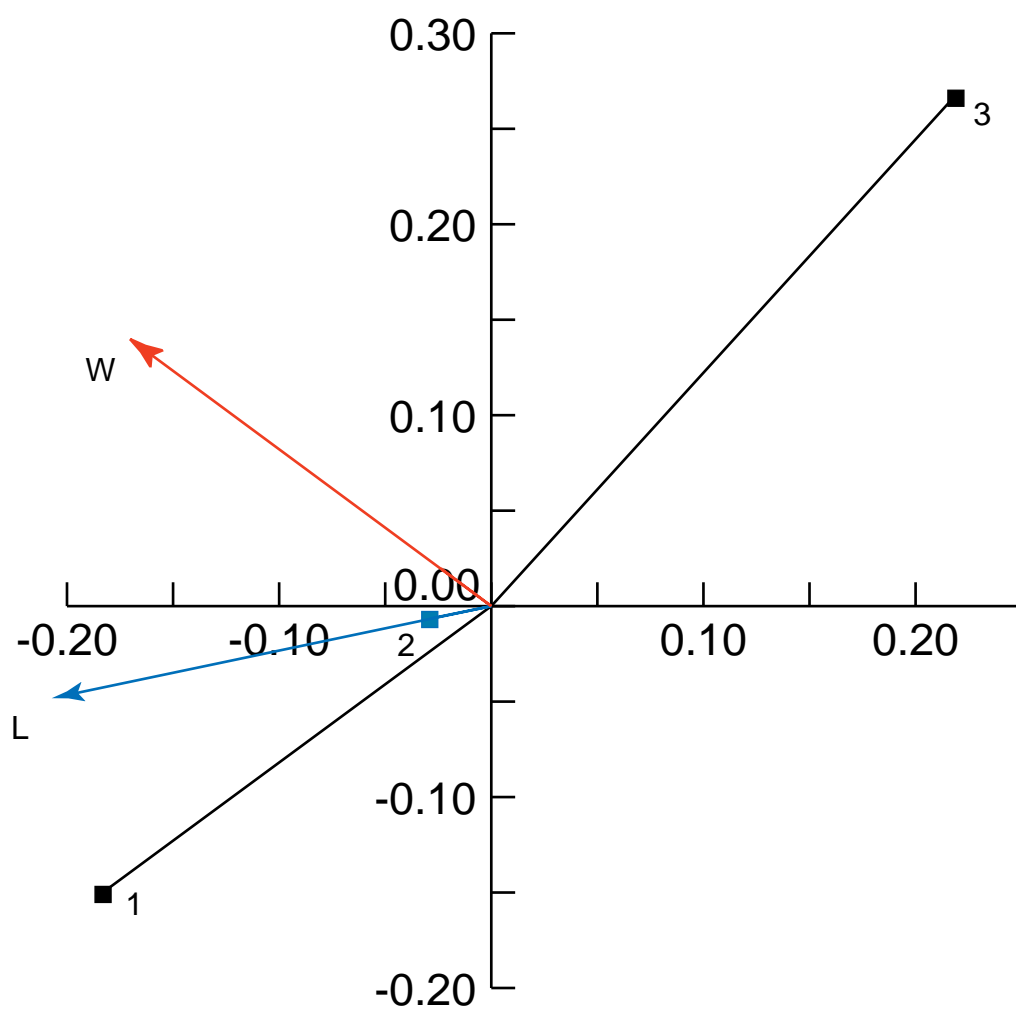The ratio of hadronic kinks to tau hypotheses is 6×10^{-3} .

Hypothesis :	$\nu_\mu \to K^\pm \to \pi^0 e\nu$		$\nu_\tau \to \tau \to e\ X$
$P(\nu N \to K\ X)_{\mathrm{NC}}$	0.2	$P(\nu N \to \tau)$	0.05
$Br\ (K^\pm \to \pi^0 e\nu)$	0.048	$Br(\tau \to e\ \nu\ \nu)$	0.18
$\int F_K(p_T)F_\tau(p_T)dp_T$	0.1	$\int F_\tau(p_T)dp_T$	1.00
$P(L_{dec} < 4.5\ \mathrm{mm})$	5.4×10^{-5}	$P(L_{dec} > 4.5\ \mathrm{mm})$	0.20
$\Pi\ P_i$	5.2×10^{-8}		1.8×10^{-3}

Table 3. Strange background estimate.
The ratio of tau to *K* hypotheses is 2.9×10^{-5} .

Parameter	Symbol	Value	δ (Value)	Prob(τ)	Prob(*bkg*)
1 Polar angle	$\Delta\phi$	0.99	0.12	0.06	0.9
2 Lepton angle	θ_{lep}	30	4	0.75	0.01
3 Decay length	L_{dec}	4.5	0.5	0.3	0.01
4 Daughter momentum	p_d	4.0	+4.0 −2.2	0.80 *central* 0.55 *worst*	0.01 0.02
5 Daughter angle wrt lepton	θ_d	93.0	6.0	0.25	0.08
6 Total Calorimter energy	E_{cal}	0.94	0.4	0.20	-
7 Charged tracks DC3*x*	N_{79}	0	0	0.15	-
8 Daughter p_T	p_T	0.37	+0.37 −0.21	0.9 *central* 0.2 *worst*	0.01 0.02
9 Daughter particle	T_d	e^+ or e^-			
10 Emulsion Module	M	1			
11 Visible Energy	E_{vis}	0.94	0.4		

Event Parameters

Polar angle

E872 Run= 3024 Event= 30175 Wght=   1.0
Triggers set
PHYSICS
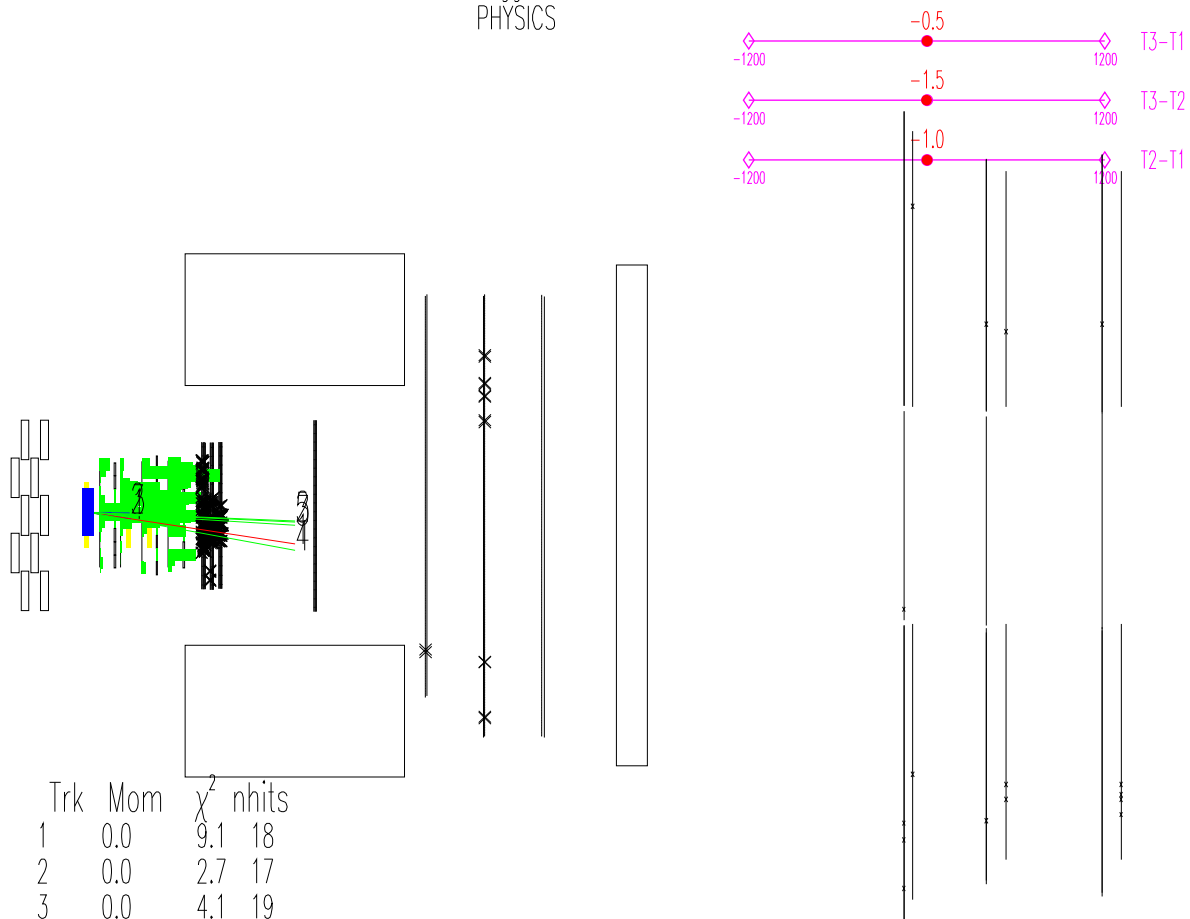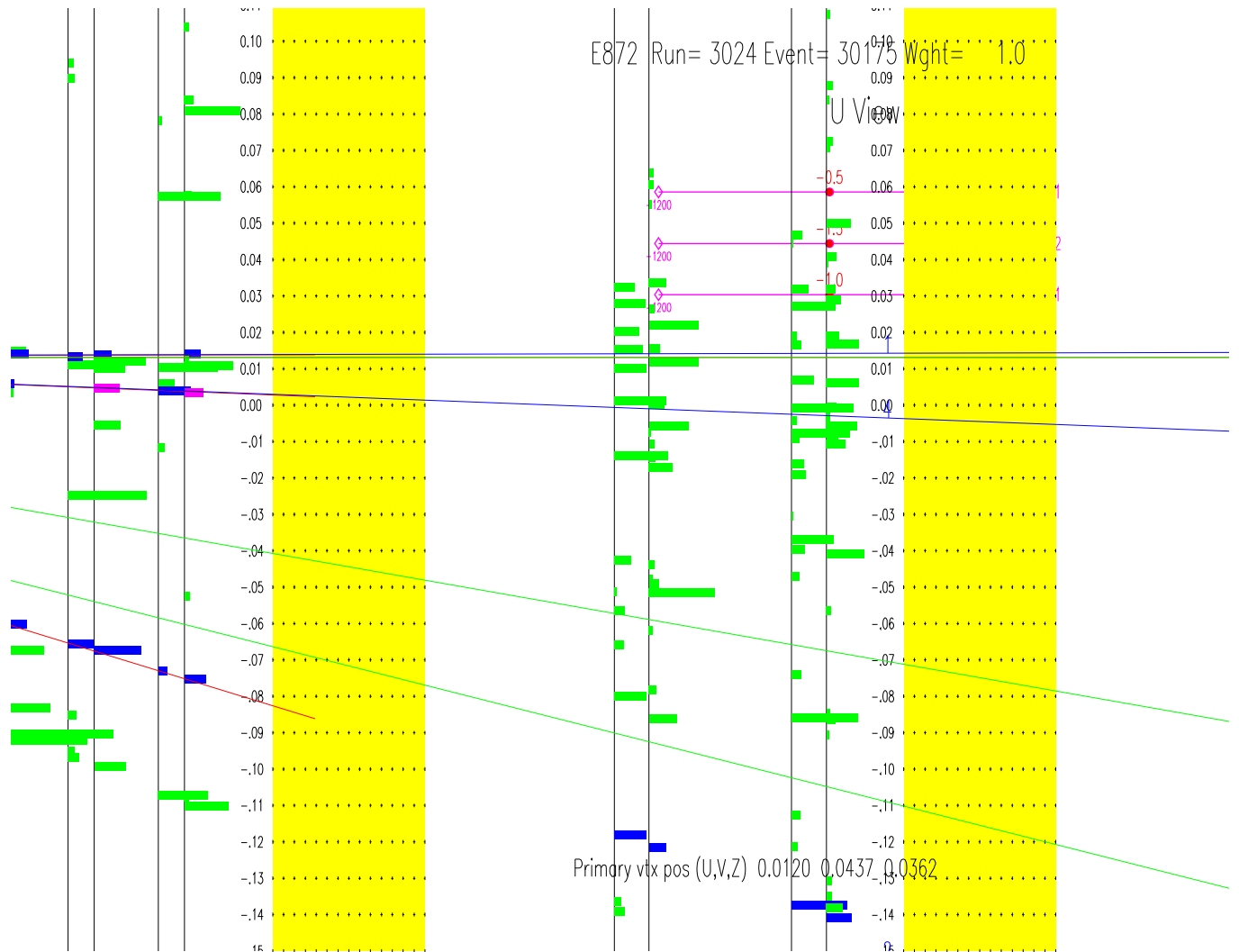
−0.5
−1200   1200   T3−T1

−1.5
−1200   1200   T3−T2

−1.0
−1200   1200   T2−T1

Trk Mom χ^2 nhits
1   0.0   9.1   18
2   0.0   2.7   17
3   0.0   4.1   19

Plan view

E872 Run= 3024 Event= 30175 Wght=   1.0

U View

Primary vtx pos (U,V,Z) 0.0120 0.0437 0.0362

SFT *u*-view : Downstream of ECC3

E872 Run= 3024 Event= 30175 Wght=   1.0

U View

Primary vtx pos (U,V,Z) 0.0120 0.0437 0.0362

SFT *u*

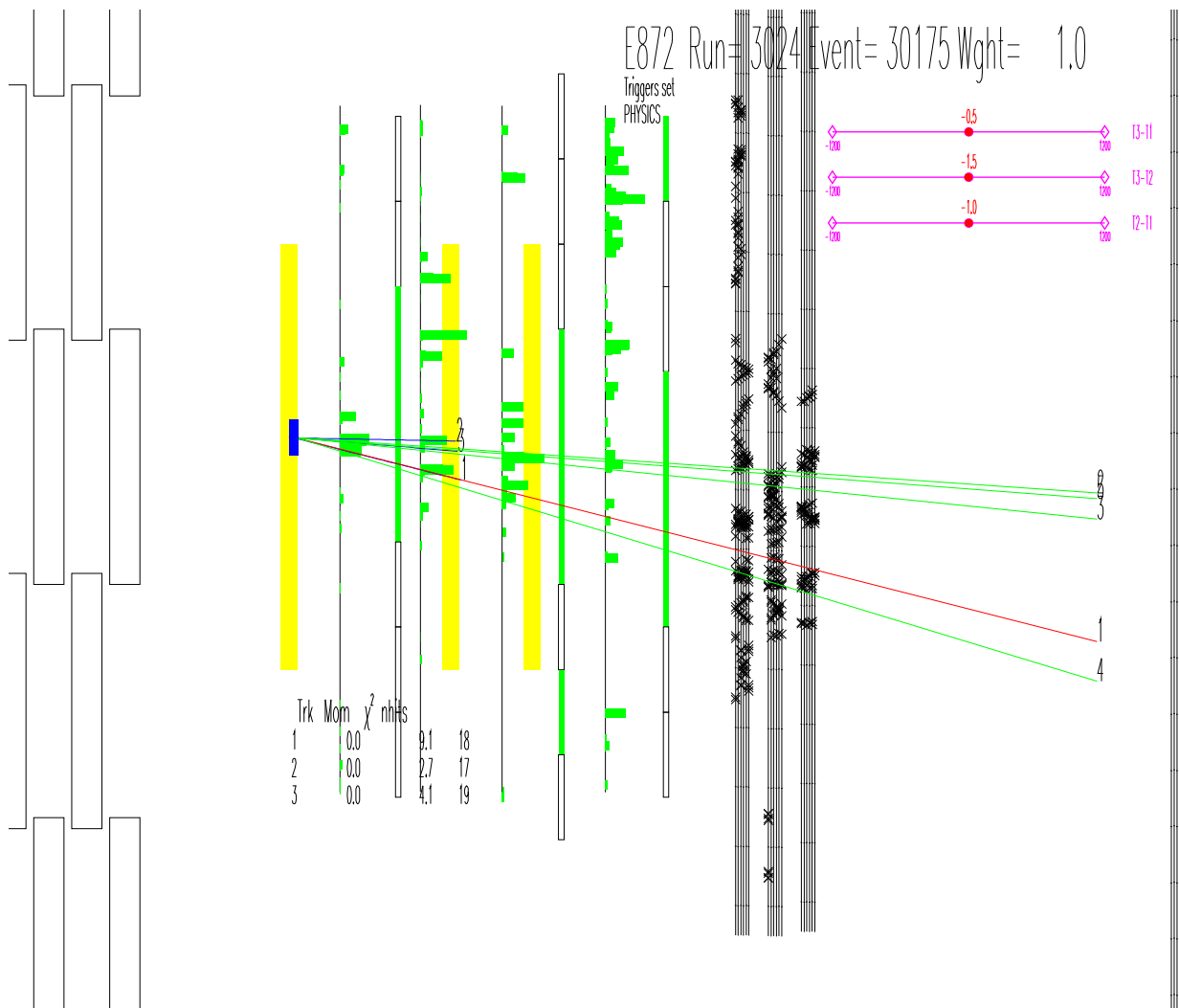E872 Run= 3024 Event= 30175 Wght= 1.0

V View

Primary vtx pos (U,V,Z) 0.0120 0.0437 0.0362

SFT *v*-view : Downstream of ECC3
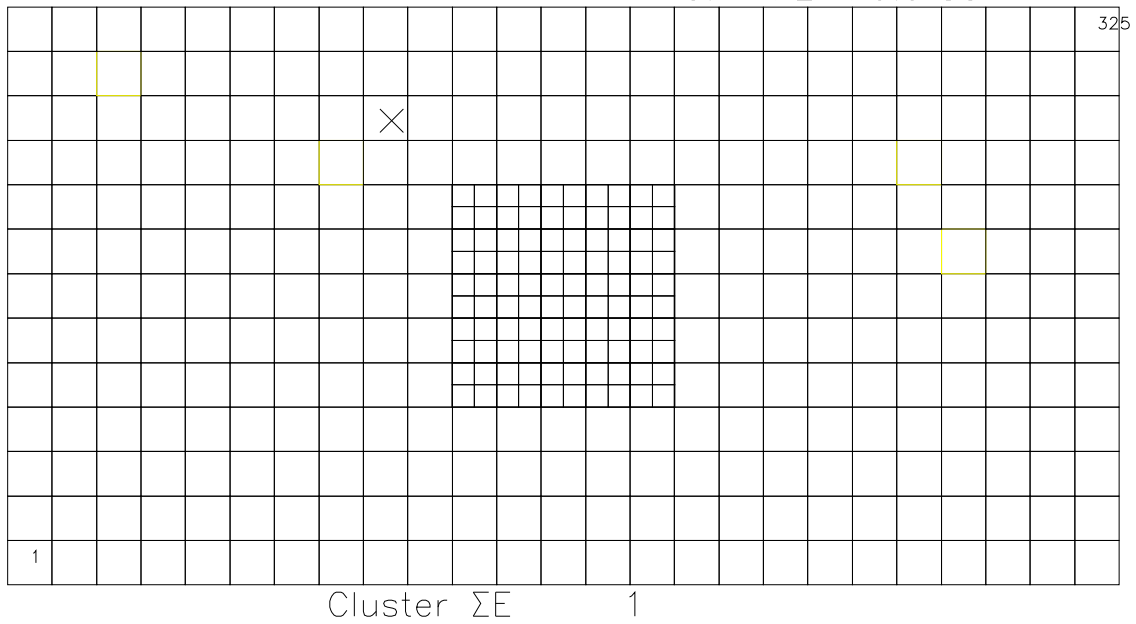
E872 Run= 3024 Event= 30175 Wght=   1.0

V View

−0.5   T3−T1
−1200   1200

−1.5   T3−T2
−1200   1200

−1.0   T2−T1
−1200   1200
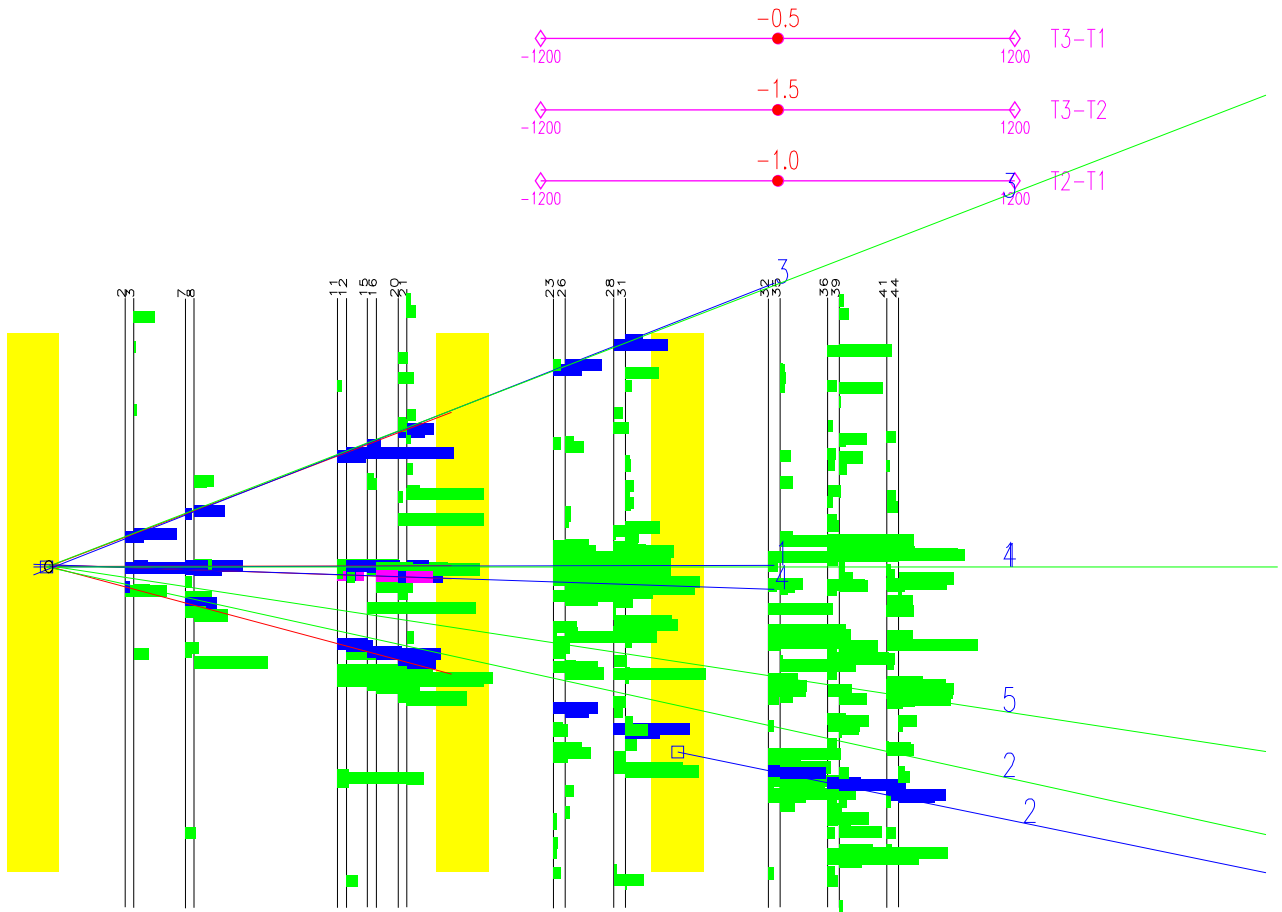
Primary vtx pos (U,V,Z) 0.0120 0.0437 0.0362
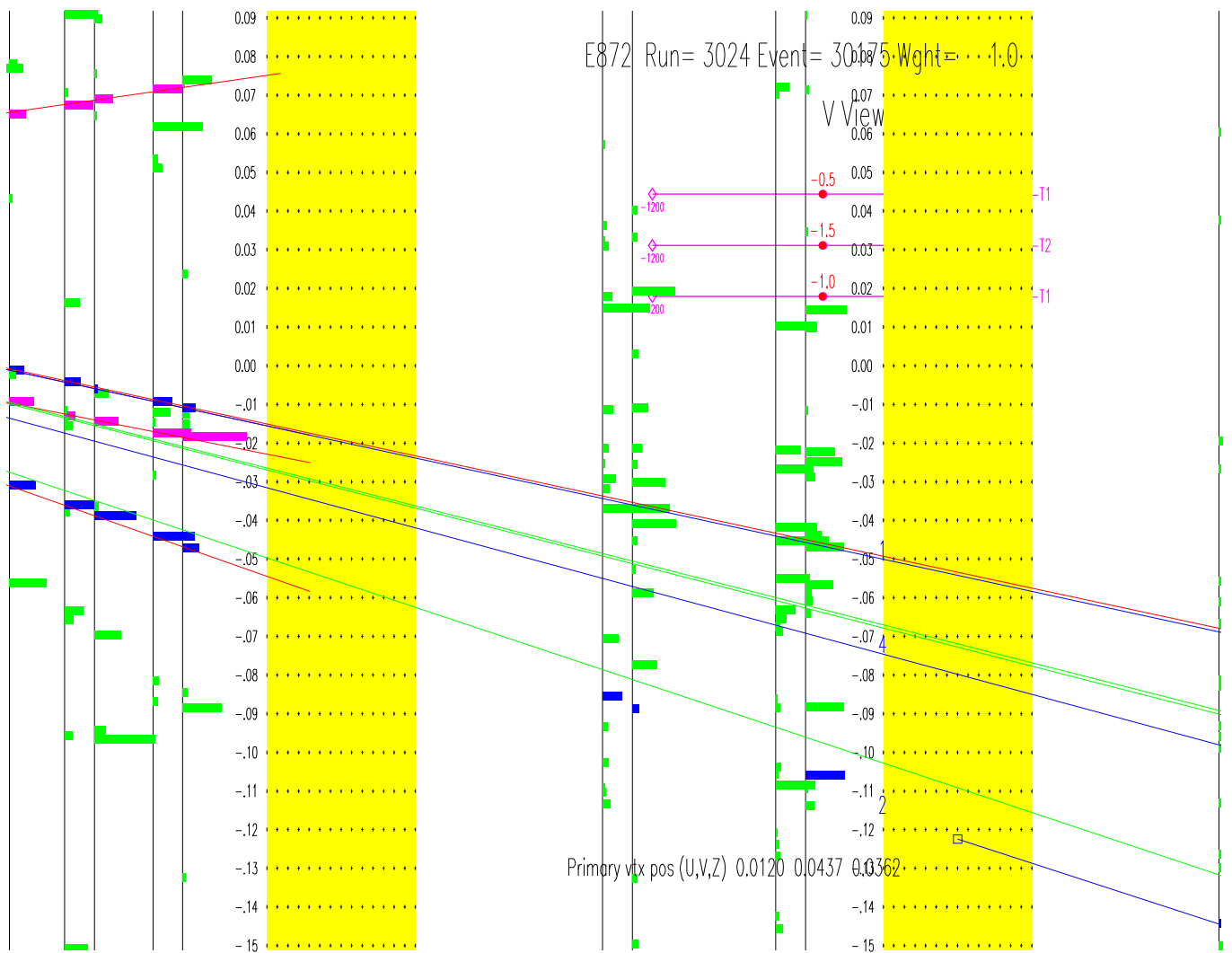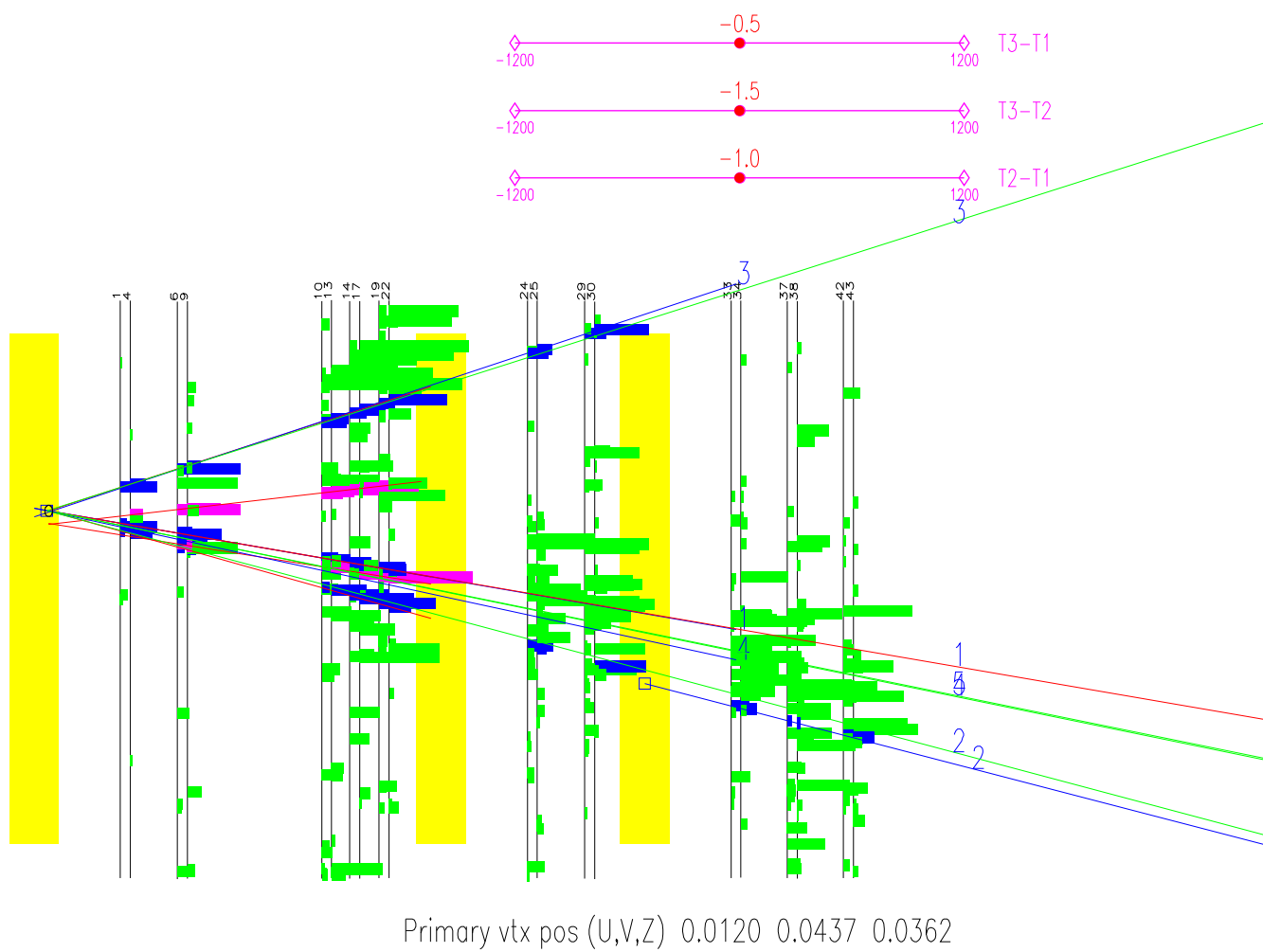
SFT *v*-view

SFT *x*-view

E872 Run= 3024 Event= 30175
E > 18 GeV
8.5 < E < 18 GeV
4.0 < E < 8.5 GeV
1.8 < E < 4.0 GeV
0.9 < E < 1.8 GeV
0.4 < E < 0.9 GeV

325

1

Cluster ΣE   1

Calorimeter
The extrapolated track (#2) is from ustream data only.